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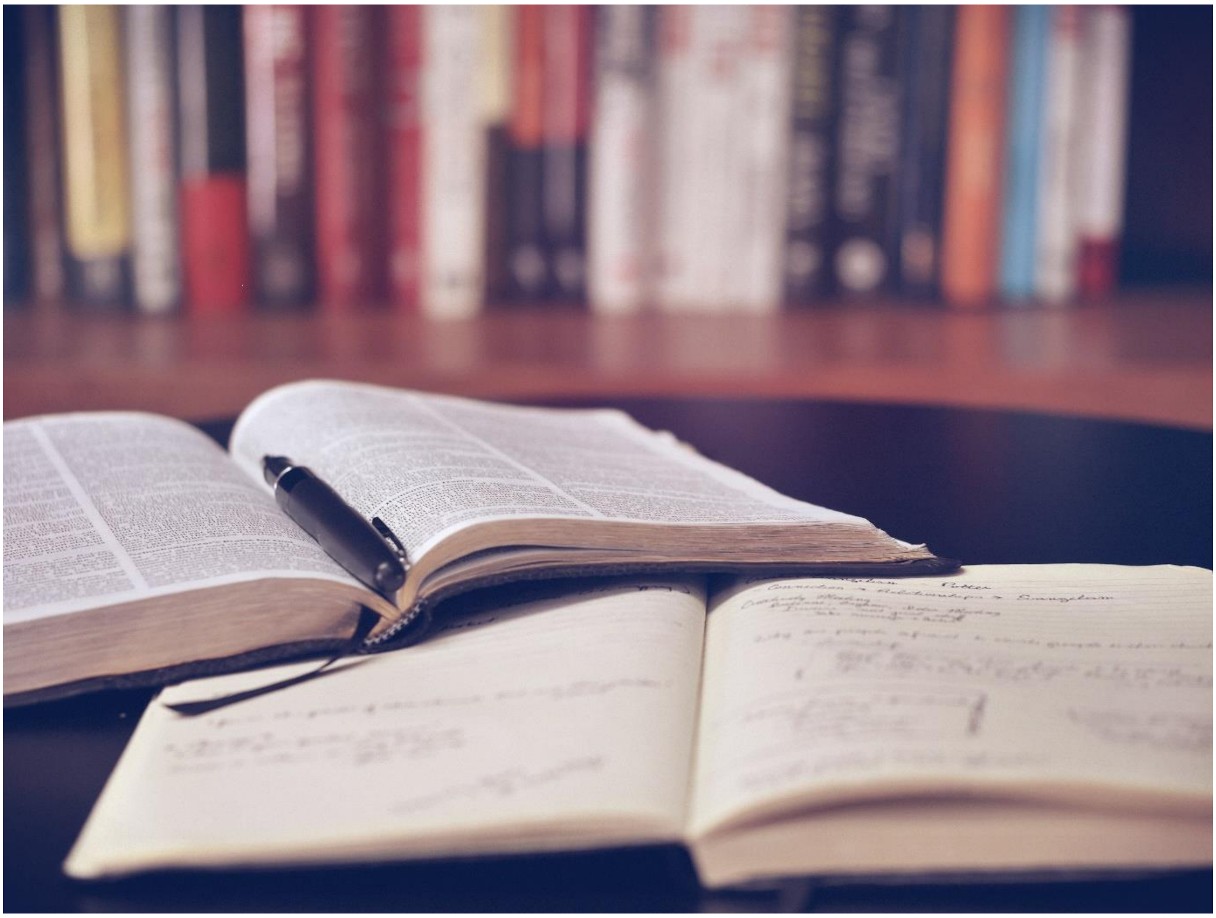

Consolidation of Prosecutor Offices

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Abstract

We investigate the impact of the consolidation of local agencies publicly-providing services, focusing on the prosecution of crime. In many states in the U.S. prosecution is a county office with a chief prosecutor directing decisions. Other states merge counties into prosecutorial districts. We show that, along with the cost savings that arises, the evidence suggests that prosecutorial services benefit from increasing returns to scale. The efficiency of prosecutorial output improves in consolidated districts. Further, we show that it is not due to differing outcomes of the criminal justice system, but in fewer inputs used.

Keywords: crime, Data Envelopment Analysis, district attorney, efficiency, jurisdiction, Propensity Score Matching, prosecution

1 Introduction

The prosecution of suspected criminals is a crucial publicly-provided service. In the United States state-level prosecutors close approximately 3 million cases a year[1], which makes up the bulk of the crimes (95% of all felonies) (Simmons, 2004), and exercise a substantial amount of discretion. For filed charges prosecutors make investigatorial investments and prosecution decisions, which can include dismissing the charges, plea bargaining (through either sentence, fact, or charge bargaining; Piehl and Bushway, 2007), or prosecuting cases at trial.

The decisions they make affect the victims and their families, the accused, and have spillover effects through deterrence. Also, importantly, the decisions affect public finances. Prosecuting crimes exhausts not only the prosecutor's budget and labor resources, but also affects the costs of the courts, jails and prisons, probationary supervision expenses, and has opportunity costs due to the backlog of cases. Thus, the funds available for prosecution should affect the quality of the criminal justice system.

In the majority of states in the U.S., the prosecution of crimes is controlled by the counties. The county prosecutor, typically known as the District Attorney, is

[1] The description of the data is given in Section 3.

allocated a budget from county and state funds. Given the alternative publicly-provided services[2] and the deadweight loss from taxation, one would like to ensure that the funds are being used effectively. Additionally, one would like to know which prosecutorial decisions and institutional rules lead to more effective use of the funds.

Some states in the U.S. have consolidated multiple county prosecutor offices into a single prosecutorial district to conserve on public finances. For example, North Carolina has one hundred counties but only forty-three prosecutorial offices. More heavily populated counties, such as Mecklenburg County which contains the city of Charlotte, are a single district. Rural counties are merged and have a single district attorney directing the prosecution. When the population of a district grows, it can be divided into separate offices. Between 2000 and 2006, for example, the state of North Carolina has done this four times.[3] Alternatively, when the public finances are especially tight, offices can be merged and costs saved. For example, when the recent recession hit the state's budget in 2010, proposals were put forth in the North Carolina Assembly to explore reductions in the number of offices.[4] Twenty-three states follow this institutional design strategy.[5]

Since the redistricting is done to conserve resources, local communities are typically concerned about the quality of the public services provided.[6] For example, District Attorney Roxanne Vaneekhoven commenting on a proposal to consolidate the prosecutor office she heads with a neighboring county claims, "bigger government does not serve the victims of crime" and argues that "district attorneys in smaller districts can give victims of crimes bigger and louder voices, and also keep district attorneys more accountable and more accessible to the people they serve" (Smith, 2011).

Here we explore this concern. Does the consolidation of prosecutorial services in fact reduce effectiveness? Work by Rasmusen, Raghav, and Ramseyer (2009) suggests it does. They investigate the size of the budgets allocated to state-level prosecutor ofices. They provide evidence, using a cross-sectional data set, that increased budgets expand both the extensive margin (number of crimes prosecuted) and the intensive margin (amount of resources devoted to each case). Limiting funds reduces prosecutorial output. Similar findings arise from the impact of resources on the prosecution of corruption cases (Alt and Lassen, 2014). We pursue an alternative hypothesis. Prosecutorial offices in the U.S. could be experiencing increasing returns to scale. The merging of multiple

[2]In a related issue, Boylan and Mocan (2015) find that court mandated increases in spending on prisons comes at the expense of welfare programs.

[3]See Bandyopadhyay and McCannon (2014) for a discussion of the redistricting in North Carolina. Also, see http://law.justia.com/north-carolina/ for a collection of annual changes in statutes in North Carolina.

[4]See http://www.clemmonscourier.net/News/041411-DA-consolidation-and-more-qcd for details on this example. Also, see Jacoby, Ratledge, Taylor, and Barrion (1996) for a detailed study of the efficacy of prosecution in North Carolina

[5]Four of these twenty-three states have consolidated all counties into a single state office with local chief prosecutors appointed, rather than elected, to their positions.

[6]http://www.clemmonscourier.net/News/041411-DA-consolidation-and-more-qcd

county offices into larger districts allows for more output to be achieved with disproportionately less resources. If this is the case, then consolidation can lead to both conserved public funds and improved public services.

To illustrate, consider the role of investigators. The prosecutor's office is provided with evidence justifying the arrest of the suspect. Additional investigation could potentially lead to improved information helping secure a trial conviction or facilitating plea bargaining. It could also expose evidence that the accused is not guilty. For smaller prosecutorial offices investigative services may be a luxury that cannot be afforded. In a nationwide, comprehensive survey of local prosecutor offices in the U.S. (see Section 3 for details on the data), 56.4% of responding offices did not employ any investigator even though they averaged 109.8 violent crimes and 937.1 property crimes committed per year. Only 24.7% of offices can afford more than one full time investigator. If two or more smaller offices can be merged, then supporting staff, such as investigators, can be employed and deployed on those cases where their services can have a valuable impact on the outcome.

To explore this hypothesis we collect data on 2298 prosecutor offices in the U.S. Rather than just focus on the correlation between budget size and convictions, as done in Rasmusen, Raghav, and Ramseyer (2009), we use a method known as Data Envelopment Analysis (hereafter DEA). DEA uses data on inputs and outputs of the production of prosecution to estimate a relative Production Possibilities Frontier. How far each office is from this frontier is a measurement of its efficiency. A second-stage analysis is done to identify the determinants of the level of efficiency. We focus on whether multiple counties being merged into a single district correlates with effective prosecution. Along with a more standard econometric analysis, we also use a Propensity Score Matching method to account for selection bias in which offices are chosen to be merged.

We find strong evidence that consolidation of county offices into prosecutorial districts leads to more efficient production. Estimates suggest that the technical efficiency measurement improves up to three-fourths of a standard deviation. Thus, consolidation promotes efficiency.

Furthermore, we are able to explore how these merged districts function. To summarize, we find that there are not statistically significant differing outcomes of the criminal justice system. These offices do not plea bargain more or dismiss fewer cases. The difference is in the inputs used. Consolidation uses fewer prosecutors and less supporting staff to achieve the same output. Merged districts are more likely, though, to have the funds to be able to hire investigators to improve upon the quality of the evidence than similarly matched offices. Therefore, the concern of lost output from consolidation lacks verification.

We are not the first to use DEA to analyze the functioning of the criminal justice system. Examples of areas of investigation include the efficiency of policing in the U.K. (Thanassoulis, 1995; Drake and Simper, 2005) and the United States (Gorman and Ruggiero, 2008); judges in Egypt (Elbialy and Garcia-Rubio, 2011) and Europe (Deyneli, 2012); and courts in Norway (Kittelsen and Forsund, 1992), Spain (Pedraja-Chaparro and Salinas-Jimenez, 1996), Germany

(Schneider, 2005), and Italy (Marselli and Vannini, 2007; Peyrache and Zago, 2012; Castro and Guccio, 2014). In fact, Gorman and Ruggiero (2009) conduct a similar analysis on prosecutors in the U.S. focusing on the relationship between socio-economic characteristics of the districts and prosecutorial effectiveness. Finally, Detotto and McCannon (2016) also analyze the efficiency of prosecutor offices. Instead, they construct state-level aggregates of prosecution, using it as a proxy for quality of publicly-provided services, and compare it to the quality of government regulation of markets, captured in economic freedom indices.

Our work also contributes to the literature investigating the incentives and behaviors of prosecutors. While the incentives and career concerns of Federal U.S. Attorneys has received attention[7] (Glaeser, Piehl, and Kessler, 2000; Boylan, 2004; Boylan, 2005; Boylan and Long, 2005), relatively little attention has been paid to the functioning of state-level prosecutors. Emphasis has been on the effect of election pressures on the decision to go to trial or plea bargain (Bandyopadhyay and McCannon, 2014; 2015a), dismissals of charges (Dyke, 2007), backlog of cases (Bandyopadhyay and McCannon, 2015b), and appeals of convictions (McCannon, 2013).[8] The exception is the DEA conducted by Gorman and Ruggiero (2009) and public financing investigation by Rasmusen, Raghav, and Ramseyer (2009). We build on the former by expanding the second-stage analysis to the effect of differences in criminal justice institutions. The latter, while a valuable investigation into the consequences of public financing decisions, differs from the work presented here in that direct productive efficiency measurements are not estimated and sample selection bias is not considered.

Our work provides important new results into the broader issue of optimal jurisdiction size. Informed by gerrymandering of legislative districts, most work on jurisdiction size focuses on the determinants and ramifications through shifting the median voter (Filer and Kenny, 1980; Gilligan and Matsusaka, 1999; 2006; Casella, 2001; Coate and Knight, 2007; Friedman and Holden, 2008; Gul and Pesendorfer, 2010). Alesina, Baqir, and Hoxby (2004) develop a theoretical model of optimal jurisdictionsize that balances economies of scale and loss from heterogeneity of residents. They apply their model to school district size and racial heterogeneity. Similarly, Levy (2005) analyzes the tradeoff between publicly-providing education and direct income redistribution, while Berry and West (2010) estimate the effect of school consolidation on outcomes. Glomm and Lagunoff (1999) theoretically investigate voluntary versus compulsory procedures for providing public goods with migration between jurisdictions. Here we contribute to the understanding of jurisdiction size by considering the trade-

[7]Rather than focusing on career concerns this literature also includes responses to sentencing guidelines (Lacasse and Payne, 1999), truth-in-sentencing laws (Shepherd, 2002), mandatory minimums (Bjerk, 2005), and the effect of punishment severity on plea bargaining (Boylan, 2012).

[8]While not specifically on elections, Daughety and Reinganum (2015) investigate, theoretically, the impact of social sanctions on prosecutors. Kessler and Piehl (1998) discuss at length the role of prosecutor discretion.

off between publicly-provided service effectiveness and cost.

Empirical investigations into publicly-provided service provision covers many applications of bureaucratic consolidation. Bates, Lafrancois, and Santerre (2011) investigate the consolidation of public health services. The focus is on the determinants of voting outcomes in the communities. Santerre (2009) studies the complementary issue of jurisdiction size and spending. These investigations do not attempt to estimate efficiency but, instead, focus on per capita spending. Bloom, Propper, Seiler, and Reenen (2015), motivated by hospital consolidation efforts, consider competition between hospitals and quality. Similarly, education is an important publicly-provided service. As stated, Alesina, Baqir, and Hoxby (2004) consider school district size and racial heterogeneity. Brasington (2003) studies the determinants of school consolidation, building on the theoretical framework of Ellington (1998). Again, the correlates of consolidation, but not efficiency measurements, are considered. Ruggiero (1996) does engage in a discussion of DEA methods applying the work to school districts, but also does not consider consolidation and jurisdiction size.

More generally, our work contributes to the understanding of bureaucratic decision making and institutional design. For example, Besley and Coate (2003) have investigated at length the tradeoff between appointed versus elected regulators. Leaver (2009) identifies the strategic information transmission of the regulated (squawking) and how it affects reputationally-motivated regulators. The responses of judges to the ideology of retention agents, whether it be the voting public or a state governor, is analyzed by Shepherd (2009). Pandey (2010) discusses the influence of corrpution on public service provisions. To the best of our knowledge, ours is the first to study changes in the scope of a bureaucratic office on efficient provision of publicly-provided services.

Section 2 briefly introduces the DEA method, while Section 3 describes the data. Section 4 presents the main results and Section 5 concludes.

2 Data Envelopment Analysis

To assess the performance of the prosecutor offices in the U.S., we employ the nonparametric technique known as Data Envelopment Analysis. DEA is a linear programming formulation used to measure the distance from the Production Possibilities Frontier in multiple input and output environments.

Different from a parametric approach, DEA does not require an *a priori* specification of the functional form of the production function as well as an *a priori* hypothesis on the disturbance term. Furthermore, DEA reduces a multiple input-output productive structure into an easier virtual uni-input-output analysis, which makes the analysis more flexible than other parametric approaches.

To elaborate, suppose there are M inputs that can be used and N outputs that can be produced by the J agents. Denote the amount of input m used by agent j as x_{jm} and the amount of output n produced by agent j as y_{jn}. Thus, the production of j is denoted by the vector $Y_j = (y_{j1}, \dots, y_{jN})$ using the input vector $X_j = (x_{j1}, \dots, x_{jM})$. Following Baker, Charnes, and Cooper

(1984) and Gorman and Ruggiero (2009), the input-orientated programming model for efficiency is[9]

$$
\begin{aligned}
TE_j &= min \;\; \theta_j \\
s.t. \;\; \sum_{i=1}^{J} \lambda_i x_{im} &\geq \theta_j x_{jm} \;\; \forall m = 1, \ldots M \\
\sum_{i=1}^{J} \lambda_i y_{in} &\geq y_{jn} \;\; \forall n = 1, \ldots, N \\
\sum_{i=1}^{J} \lambda_i &= 1 \\
\lambda_i &\geq 0 \;\; \forall i = 1, \ldots J
\end{aligned}
$$

The solution to this problem, for each agent, provides a measurement of efficiency, known as *technical efficiency*. Hence, technical efficiency is defined as the equi-proportional reduction of observed inputs consistent with existing production. Consequently, values of the technical efficiency range between zero and one. A value of one represents no uniform reduction in inputs to achieve observed levels of output, so that the agent is producing efficiently. Values near zero are interpreted as the situation where the observed output could be produced with large equi-proportional reductions in inputs. Such an agent is operating ineffectively. The smaller this value, the more ineffective is its production.

3 Data

Data on the production of prosecution comes from the *Census of State Prosecutors, 2007* conducted by the Department of Justice. The survey collects basic information from every state-level prosecutor office in the U.S. In 2007, the last survey produced, there were 2330 offices in the United States. It is common in many states for prosecutor offices to be county-level offices (e.g. New York). Some states, though, organize a few counties into prosecutorial districts. For example, in North Carolina more heavily-populated counties (such as Mecklenburg which contains Charlotte) are a prosecutorial district. Typically, two or three less-populated counties are grouped together.

From this survey, four output variables and two inputs variables are calculated. The input variables are the number of prosecutors employed and the

[9]In the literature two main DEA models are considered: the DEA-CCR model developed by Charnes, Cooper, and Rhodes (1978), which assumes that all agents are operating at constant returns to scale (CRS); the DEA-BCC model, developed by Banker, Charnes, and Cooper (1984), which is based on variable returns to scale (VRS) hypothesis. In this study, the Charnes, Cooper, and Rhodes (CCR) model is adopted.

number of supporting staff reported. Part-time workers are coded as 0.5 of a worker. An office has a chief prosecutor and a team of assistant prosecutors. A number of different potential supporting staff can be employed in an office. Examples of categories recorded are office managers, civil attorneys, victim advocates, investigators, and secretaries/clerical staff. Rather than disentangle the differences in labor input provided, all non-prosecutorial staff are aggregated into the supporting staff variable.

Four output variables are provided in the census and used. They are (1) the number of cases closed during the year, (2) the number of criminal convictions obtained during the year (either through guilty verdicts at trial or guilty pleas), (3) the number of jury verdicts rendered (either a conviction or an acquittal), and (4) the population of the district. Each of these measurements captures prosecutorial production. The number of closed cases is a direct measurement of how much is handled, or rather, the extensive margin. This is an incomplete measurement, though, because it does not capture the level of effort and resources devoted to prosecution, the intensive margin. Thus, the number of convictions obtained captures some of this effect. Also, courtroom trials consume a substantial amount of resources and, therefore, presumably generate large expected benefits to the office. Thus, the number of jury trials measures output as well. Finally, as is common in the literature (Gorman and Ruggiero, 2009), the population of the district is used as a proxy for the number of non-prosecution services (e.g. drug awareness programs) provided.

A number of adjustments are made to the data. First, the census survey queried each office on the total number of staff, total supporting staff, and asked for a breakdown of staff by role. Due to reporting error or intentional omissions, the greater of the total supporting staff and the sum of the breakdown in staff roles is used in the analysis. In 105 observations only the total supporting staff was reported. Also, for 26 observations only the total staff was given. For these cases the number of prosecutors is subtracted to measure the supporting staff. Second, 30 observations are eliminated due to no responses on supporting staff questions. This represents only 1.3% of the population. The average number of prosecutors in these districts is 1.83, which is substantially less than the sample average. Third, with regards to the output variables, two observations are dropped due to missing information. Consequently, there are 2298 observations used in the analysis.[10]

For the United States there are a total of 2.91 million closed cases generating 2.18 million convictions (a 75% conviction rate). In 2007 there were 73,274 jury trials, which is 2.5% of all closed cases. Table 1 provides descriptive statistics on the inputs and outputs used in the DEA.

[10] Gorman and Ruggiero (2009) limit their analysis to districts with populations between 100,000 and 500,000. In 2007 this range constitutes only 20.3% of the offices in the U.S. As a consequence, many of these data issues are not present there.

TABLE 1: PROSECUTORIAL PRODUCTION
($N = 2298$)

description	mean	min	max	st. dev.
inputs				
# of prosecutors	12.00	0.5	926.5	37.5
# of supporting staff	22.52	0.17	1247.5	66.5
outputs				
# of closed cases	1314.8	0	64,585	3652.6
# of individuals convicted	940.4	0	58,050	2659.6
# of jury trial verdicts	32.0	0	3000	108.2
population of the district	132,210.2	474	9,948,081	377,911

There is substantial variation in the size of caseloads of the districts. The low proportion of convictions that come from jury trials (3.4%) matches previous observations in the literature (Bandyopadhyay and McCannon, 2014). Jury trials are a resource-intense, rarely-used tool of prosecution. The variables used in the second-state of the analysis are presented in Table 2.

TABLE 2: DESCRIPTIVE STATISTICS
($N = 2298$)

	description	mean	st. dev.
TE	technical efficiency	0.159	0.099
multiple	= 1 if more than one county in a district	0.149	0.356
counties	# of counties in prosecutorial district	1.335	0.951
white	% of population that is white	0.889	0.139
male	% of population that is male	0.498	0.034
ur	unemployment rate	4.701	1.609
$lfpr$	labor force participation rate	0.486	0.057
income	median household income	44166	10759
education	proportion with a high school degree	83.603	7.510
poverty	% of population below poverty line	0.490	0.355
population	population	$1.3\text{x}10^5$	$3.8\text{x}10^5$
rep	% of votes cast for McCain in 2008 election	0.557	0.138
voter part	% of population that voted in 2008 election	0.464	0.221

Thus, approximately 16% of the sample consists of prosecutorial districts that collect multiple counties into one office. The descriptive statistics are calculated over the sample of prosecutor offices, which are not equal in population size. Hence, the mean values of *poverty* and *rep*, for example, do not match national values.[11]

4 Results

The hypothesis is that there is a relationship between measured efficiency of the prosecutorial office and its composition. Comparing the subsample with multiple counties to the subsample of single county districts, the average value of TE is

$multiple = 1$	0.224
$multiple = 0$	0.148

and a difference arises. Districts containing more than one county have an average technical efficiency approximately two-thirds of a standard deviation greater than the full sample mean. This suggests that consolidation increases productive efficiency. Of course, regression analysis, controlling for differences in the composition and characteristics of the districts, is needed.

4.1 Econometric Investigation

The preliminary results illustrate the effect of consolidation of counties on technical efficiency. Table 3 presents the second-stage results.

[11] John McCain, for example, received 45.7% of the votes, while Barack Obama received 52.9%.

TABLE 3: RESULTS
(dependent variable = TE; $N = 2298$)

	I		III	
multiple	0.062 ***	(0.011)	0.073 ***	(0.007)
counties	0.005	(0.003)		
white	0.048 **	(0.021)	0.047 **	(0.021)
male	-0.588 ***	(0.109)	-0.587 ***	(0.109)
ur	0.008 ***	(0.002)	0.008 ***	(0.002)
lfpr	-0.109 **	(0.051)	-0.107 **	(0.051)
income	2.1x10^{-6} ***	(2.4x10^{-7})	2.1x10^{-7} ***	(2.4x10^{-7})
education	-0.001 ***	(0.0003)	-0.001 ***	(0.0003)
poverty	0.020 ***	(0.006)	0.019 ***	(0.006)
population	8.0x10^{-9}	(8.7x10^{-9})	8.0x10^{-9}	(8.7x10^{-9})
rep	0.016	(0.019)	0.017	(0.019)
voter part	-0.026 ***	(0.006)	-0.027 ***	(0.006)
constant	0.391 ***	(0.064)	0.395 ***	(0.064)
adj R^2	0.135		0.135	
F	24.7 ***		26.7 ***	
AIC	-4429.3		-4429.5	

Heteroscedasticity-robust standard errors are presented in the parentheses.

*** 1%; **5%; * 10% level of significance

The positive and statistically significant coefficient on *multiple* provides evidence that the consolidation of counties into prosecutorial districts corresponds with more efficient functioning of the criminal justice system. Specifically, it is whether or not there is consolidation, and not the number of counties consolidated, that matters. Controlling for the characteristics of the population served, having multiple counties in a prosecutorial district increases the measured efficiency of the office by 45.9% at the mean, or rather, approximately three-quarters of a standard deviation.

Table 3 presents heteroscedasticity-robust standard errors. If, alternatively, unadjusted standard errors or standard errors clustered by state are calculated, the main result persists. Additionally, if log transformations of the dependent and control variables are considered, the significance of *multiple* remains. Furthermore, the results presented are straightforward OLS estimates. Given that the dependent variable takes values only between zero and one, a concern arises that OLS might be inappropriate. The appendix provides the results from a fractional regression model (Papke and Woolridge, 1996). The main result persists.

As one can also see in Table 3, most of the control variables are also related to efficiency of prosecutorial production. If, though, all controls are excluded from the specification, the statistical significance of *multiple* persists.

The DEA analysis has been further implemented by calculating the ratio between constant returns to scale and variable returns to scale technical efficiency scores, that provides scale efficiency scores that can be either constant, decreasing or increasing returns to scale (CRS, DRS and IRS, respectively) (see Charnes *et al.*, 1978; Banker *et al.*, 1984; Cullinane *et al.*, 2004). Following Färe and Grosskopf (1994) and Löthgren and Tambour (1996) if this ratio is equal to one, then the observation is experiencing constant returns to scale. If the ratio is less than one, then it has scale inefficiency and increasing or decreasing returns to scale is observed. In the latter case, the non-increasing returns-to-scale (NIRS) technology is used to investigate the nature of agent's scale inefficiency. If the score efficiency in the NIRS technology is not equal to the CRS technical efficiency score, the scale inefficiency is explained by the fact that the agent is exhibiting DRS. Otherwise, it has IRS.

According to the abovementioned procedure, the returns to scale of each agent is obtained. The binary variable *scale* represents the nature of the scale efficiency/inefficiency. If it has increasing returns to scale, the variable IRS equals one. It takes a value of zero otherwise.

In the sample, 32.4% of the observations have $IRS = 1$. Interestingly, the two subsamples ($IRS = 1$ and $IRS = 0$) differ in the ratio of multiple counties, average income per capita, demographics (race and political ideology) and average population. Table 4 presents the comparison of the subsamples.

TABLE 4: SUBSAMPLE COMPARISON

	$IRS = 1$	$IRS = 0$	Δ
multiple	0.256	0.097	0.159 ***
white	0.826	0.918	-0.092 ***
male	0.492	0.499	-0.007
ur	4.693	4.691	0.002
lfpr	0.493	0.483	0.010
income	49,503	41,484	8019 ***
education	84.362	83.277	1.085
poverty	0.522	0.476	0.046 **
population	353,894	27,375	326,519 ***
rep	0.512	0.580	-0.068 ***
voter part	0.458	0.469	-0.011
N	755	1555	

From this basic descriptive analysis, it seems that multiple counties tend to have a higher likelihood of showing increasing returns to scale than the subsample of single county districts. Table 5 estimates a binary probit model with IRS as the dependent variable. QML standard errors are presented in parentheses and the marginal effects are reported.

TABLE 5: INCREASING RETURNS TO SCALE
(dependent variable = IRS, N = 2298)

	marginal effect	st.error
multiple	0.066 ***	(0.020)
white	-0.137 *	(0.076)
male	-1.850 **	(0.916)
ur	0.003	(0.007)
lfpr	-0.012 ***	(0.236)
income	$3.8 \text{x} 10^{-6}$ *	($1.2 \text{x} 10^{-7}$)
education	0.260	(0.145)
poverty	-0.002	(0.028)
population	$6.8 \text{x} 10^{-6}$ ***	($2.8 \text{x} 10^{-7}$)
rep	-0.024	(0.064)
voter part	-0.373 ***	(0.121)
adj R^2	0.803	
Wald	-16689.2 ***	
log likelihood	-281.5	

QML standard errors are presented in the parentheses.

*** 1%; **5%; * 10% level of significance

The probability that an observation is measured to be experiencing increasing returns to scale is positively correlated with being consolidated with multiple counties. This further supports the hypothesis that consolidation improves efficiency of prosecution.

While the previous analysis focuses on the measurement of productivity via DEA, insight into the sources of the improved efficiency needs exploring. The specification of column II in Table 3 is replicated, but dependent variables of the inputs and outputs are used. Table 6 presents these additional results. All control variables included in Table 3 are included in each specification, but are not reported. Only the estimated coefficient for *multiple* and its robust standard error is given in Table 6.

TABLE 6: SOURCES OF EFFICIENCY ($N = 2298$)

	multiple coefficient	robust st.error
Inputs		
# of prosecutors	-3.714 ***	(0885)
# of supporting staff	-4.143 **	(1.840)
Invest	0.924 ***	(0.172)
Outputs		
Closed	243.0 *	(131.0)
Convict	151.3	(97.7)
Jury	6.49	(4.51)
Jury/Closed	-0.056	(0.045)

Heteroscedasticity-robust standard errors presented in all rows, except the QML standard error is presented in the specification with *Invest* as the dependent variable (since this is a logit estimation).

Each specification includes a constant term along with *white*, *male*, *ur*, *lfpr*, *income*, *education*, poverty, *population*, *rep*, and *voterpart* as control variables.

*** 1%; **5%; * 10% level of significance.

The results indicate that the consolidation of counties into prosecutorial districts is primarily correlated with reduced input usage and not with outputs. The exception is the (logit) estimation with the indicator variable *Input* capturing whether or not investigators are employed. While overall inputs are less, the use of investigators is more likely. At the mean, the marginal effect is that consolidation increases the likelihood of employing at least one investigator by 22.5 percentage points.

Some effect exists for an increase in output with consolidation of multiple counties. The coefficients on *Closed*, *Convict*, and *Jury* are all positive. This suggests that more output is being obtained. These effects, for the most part, are statistically insignificant.

4.2 Propensity Score Matching

A concern arises in the analysis of policy in the legal system is that laws are not exogenous. States that choose not to merge their counties into coarser prosecutorial districts may be different in some important dimension. Within states that do merge, those counties the state government chooses not to merge are done so, presumably, for a reason. Thus, the econometric strategy previously employed may suffer from mis-attributed effects. The difference in prosecutorial efficiency observed may be driven by the characteristics of those that did not merge, rather than the policy itself.

A technique developed to address the sample selection bias is known as Propensity Score Matching (Rosenbaum and Rubin, 1983; Heckman, Ichimura, and Todd, 1998; Smith, Ichimura and Taber, 2001). The ideal analysis would consider a sample of observations, which are identical except for the policy difference. The differenence in the outcomes of the "treated" sample and the "control" sample can then be attributed to the policy treatment. The matching technique is to select a control group of prosecutor offices that have not merged which are similar to the treated offices, except in the policy. In the first stage a logit regression is estimated on the data set using measurable variables of the characteristics of the districts to predict the likelihood of being in the treated group. The estimated parameters are used to calculate the fitted probabilities of being in a merged district. These fitted values are known as the propensity scores.

For each observation with $multiple = 1$ the observation with $multiple = 0$ with the closest matching propensity score is identified. The subsample of the treated observations (those with $multiple = 1$) and the subsample of matched controls are created. Differences in the means of the two subsamples can be analyzed to appreciate the effect of the policy.

Propensity Score Matching is rather common in empirical legal studies. For example, Helland and Tabarrok (2004) use it to investigate bail jumping differences between those who received funds from private bail bondsmen and those who receive public bonds. Starr (2015) using Propensity Score Matching to investigate gender differences in sentencing. The impact of Catholic school education on drug use and sales is undertaken by Mocan and Tekin (2006). It has been used to detect corruption in Chinese asset sales (Fisman and Wang, 2015) and the difference between company-managed and franchised establishments in workplace monitoring (Freedman and Kosova, 2014).

The appendix provides the results of the first-stage estimation of the propensity scores. The socio-economic controls and crime data is used to match counties with the treatment to similar counties without the treatment. The number of observations in the treatment subsample may be greater than the number of observations in the control subsample since it is possible that two data points in the former may most closely match the same observation in the latter. Following these methods, while there are 346 observations with multiple counties included into a single district, the control subsample has 273 observations.[12]

The appendix contains a comparison between the treatment and control subsamples and illustrates the similarity in the samples. Along with comparing the mean value of the technical efficiency of the two subsamples, Table 7 also presents important comparisons in the inputs used and outputs produced.

[12] Also, a caliper is typically used to include as controls only those observations sufficiently close in propensity matching score. If a rather tight caliper of ± 0.001 is used the results presented in this subsection do not change substantially. Here the control subsample has 191 data points.

TABLE 7: PROPENSITY SCORE MATCHING RESULTS
(subsample means)

	Treatment ($multiple = 1$)	Control ($multiple = 0$)	Δ
TE	0.224	0.151	0.073 ***
$Closed$	1909.8	1844.5	65.3
$Convict$	1365.7	1429.2	-63.5
$Convict/Closed$	0.746	0.823	-0.077
$Jury$	43.00	43.33	-0.33
$Jury/Closed$	0.042	0.048	-0.006
# of investigators	2.363	4.138	-1.775 ***
% with an investigator	70.5%	48.4%	22.2 ***
# of prosecutors	11.97	20.57	-8.60 **
# of supporting staff	23.45	37.37	-13.92 *
budget	$2,021,416	$5,061,353	-$3,039,937 **

*** 1%; **5%; * 10% level of significance

The comparsion presented in Table 7 is revealing. Prosecutorial districts comprised of multiple counties are substantially more efficient in the prosecution of suspected criminals than similar districts. The difference in the mean values of *TE* is statistically significant. The disparity exceeds three-fourths of the full sample standard deviation, which is consistent with the econometric results presented in the previous subsection.

Comparing the input and output variables provides some evidence of the source of this difference. The treatment subsample closes more cases while obtaining fewer convictions. This can be explained by more effective screening of case files submitted. Also, there are slightly fewer jury trials. The differences in these outcome variables, though, are statistically insignificant. Hence, there are not important differences in outcomes caused by consolidating counties into prosecutorial districts. In other words, there is not evidence of worsening outcomes in criminal justice.

Table 7 does, though, illustrate important differences between the two subsamples. Consolidated districts are more likely to be able to employ investigators, but use fewer of them. Substantially fewer prosecutors and supporting staff are employed to achieve the same output. Consequently, the amount of money spent on prosecution is substantially less. All of these distinctions are highly statistically significant and mirror the results presented in Table 6. This suggests that sample selection bias was not an important driver of the results in Section 4.1. Focusing only on the budget allocated to the prosecutor's office, the average cost of each case closed is $2744 in districts consisting of single counties and $1058 in merged prosecutorial districts, or rather, over a 60% reduction.

Therefore, the efficiency gains from consolidation of multiple counties into prosecutorial districts comes from resource conservation. There are not significant differences in prosecutorial output, but there are substantial differences in the amount of resources used.

The results in Table 7 consider the subsample of matches with replacement. Two alternatives can be considered. First, it is common to employ a caliper, as in Helland and Tabarrok (2004). The appendix considers the results with the standard 0.001 caliper. Similar means arise in this subsample. Also, the matching with replacement tactic opens up the possibility that two treated observations match best with the same control. Thus, the size of the two subsamples are not equal. An alternative estimation, as is done in Mocan and Tekin (2006), is to weight the observations by the number of matches in a Weighted Least Squares estimation. The results are presented in the appendix. The statistical significance of the consolidation remains. Thus, the results presented in Table 7 are not sensitive to the matching method employed.

5 Conclusion

Does the consolidation of local agencies publicly-providing services hurt its effectiveness? This question is addressed considering prosecutor offices. In many states in the U.S. the prosecution of crime is a county office with an elected, chief prosecutor directing decisions. Other states merge counties into a prosecutorial district. We show that along with the cost savings that arises, the evidence suggests that prosecutorial services benefit from increasing returns to scale. The efficiency of prosecutorial output improves in consolidated districts. Further, we show that it is not due to differing outcomes of the criminal justice system, but in fewer inputs used.

The work has important policy implications. Given constrained public finances, the consolidation of prosecutor offices does not necessarily compromise the quality of the services. This is important because there are strong spillover effects from prosecution, e.g. deterrence. Furthermore, an important difference between the control and treatment groups is the use of investigator services. While measurements of the quality of evidence are not available in the data, one would expect that increased investments in investigation should improve the quality of the decision making. Not only would one expect better evidence to be obtained to facilitate the conviction of those who cause harm, but wrongful convictions would be reduced. Suggestive evidence exists though. The proportion of cases closed that end in conviction decrease by approximately eight percentage points. This is consistent with improved screening, which proportionally should be innocent (or at least non-culpable) defendants.

By estimating productive efficiency the work does not address what is optimal prosecutorial decision making. For example, disparities by race, gender, and ethnicity (Gazal-Ayal and Sulitzeanu-Kenan, 2010; Rehavi and Starr, 2014; Starr, 2014), inequities in application of plea bargaining (Bibas, 2004), mistakes in convictions (McCannon, 2013), and the distortions caused by re-election concerns (Bandyopadhyay and McCannon 2014; 2015a; 2015b) are important considerations to include in debates of institutional design. To fully appreciate the implications of merging county-level offices into prosecutorial districts future research needs to further investigate the decision making differences across offices.

To quantify the potential impact of consolidation, the results presented estimate that 32.4% of the prosecutor offices in the U.S. are experiencing increasing returns to scale. Taking the most conservative estimate that all consolidated offices have IRS (and no more consolidation is feasible), this leaves 552 offices in the U.S. with potential efficiency gains from merger. Given that the matching results show that the average savings in the budget of the merged districts is over $3 million per year, a pairwise merger of these offices with a neighbor (assuming no improvement in the neighbor's expenses) would reduce the direct costs to prosecution by approximately $1.7 billion. Given this conservative estimate employing strong assumptions, this public policy should be given further consideration.

While we focus here on the prosecution of crime, the work points to broader efficiency gains to consolidation of local services. County lines, for example, were originally drawn for convenience. The consequence of the formation of the jurisdictions has been shown to still have spillover effects today. See, as an example, Libecap and Lueck (2011) for an investigation into the formation of property lines in counties and their implications today. While the debate regarding decentralization focuses primarily on the national government versus state/provincial governments and the incentives on spending (Oates, 1972; 1999; Baqir, 2002; Kessler, 2014), the results presented here point to a new dimension of the argument - cost and effectiveness of publicly-provided services are not always traded off. There is no reason to believe that other publicly-provided services could not benefit from consolidation. We provide strong evidence that consolidation benefits the prosecution of crime, and future research should investigate the possibility in other services.

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7 Appendix

First, the appendix provides the second-stage results using, alternatively, fractional regression results (Papke and Woolridge, 1996). This is important since the dependent variable is restricted to values between zero and one. Fractional regressions have been applied to the second-stage analysis of DEA (Ramalho, Ramalho, and Henriques, 2010) as well.

TABLE A1: FRACIONAL REGRESSION RESULTS
(dependent variable = TE; $N = 2298$)

	I		III	
multiple	0.332 ***	(0.059)	0.319 ***	(0.062)
white	-0.142	(0.173)	-0.125	(0.179)
male	-0.884 ***	(0.757)	-0.328	(0.751)
income	1.0×10^{-5} ***	(1.5×10^{-6})		
ur			-0.009	(0.011)
education			0.641 ***	(0.214)
population	1.0×10^{-7} ***	(3.5×10^{-8})	1.6×10^{-7} ***	(5.1×10^{-8})
violent	-2.0×10^{-4} **	(8.3×10^{-5})	-2.4×10^{-4} ***	(8.5×10^{-5})
constant	-1.263 ***	(0.401)	-1.600 ***	(0.453)
State Controls?	YES		YES	
AIC	0.657		0.659	

Heteroscedasticity-robust standard errors are presented in the parentheses.

*** 1%; **5%; * 10%

This confirms the results previously presented. The consolidation of counties into prosecutorial districts corresponds with more efficient functioning of the criminal justice system. Again, it is whether or not there is consolidation, and not the number of counties consolidated, that matters. Controlling for the characteristics of the population served, having multiple counties in a prosecutorial district increases the measured efficiency of the office by 45.9% at the mean, or rather, approximately three-fourths of a standard deviation.

Table A1 presents heteroscedasticity-robust standard errors. If, alternatively, unadjusted standard errors or standard errors clustered by state are calculated, the main result persists. Additionally, if log transformations of the dependent and control variables are considered, the significance of *multiple* remains.

Data Envelopment Analysis is also able to take alternative measurements of production. Two are *pure technical efficiency* (PTE) and *scale efficiency* (SE). Pure technical efficiency contrasts with technical efficiency in that the former allows for variable returns to scale, while the latter assumes constant returns to scale. If a district is experiencing scale inefficiency, then PTE will be larger than TE. Thus, we also consider the ratio of the two, SE (where $SE = TE/PTE$). Larger values of SE are associated with higher scale inefficiencies. Table A2 considers these alternative measurements of efficiency.

TABLE A2: ADDITIONAL RESULTS
($N = 2298$)

	PTE		*SE*	
multiple	0.073 ***	(0.007)	0.244 ***	(0.013)
white	0.113 ***	(0.044)	-0.072 **	(0.052)
male	0.788 ***	(0.284)	2.378 ***	(0.381)
ur	-0.013 ***	(0.004)	0.025 ***	(0.005)
lfpr	0.490 **	(0.130)	-0.743 **	(0.142)
income	$7.4\text{x}10^{-6}$ ***	($6.9\text{x}10^{-7}$)	$1.2\text{x}10^{-5}$ ***	($6.7\text{x}10^{-7}$)
education	0.002 **	(0.001)	-0.003 ***	(0.001)
poverty	-0.013 ***	(0.013)	0.069 ***	(0.015)
population	$8.2\text{x}10^{-8}$	($1.3\text{x}10^{-8}$)	$-6.4\text{x}10^{-8}$ ***	($1.3\text{x}10^{-8}$)
rep	0.264 ***	(0.046)	-0.272 ***	(0.064)
voter part	-0.023	(0.033)	-0.099 ***	(0.044)
constant	-0.347 ***	(0.170)	1.961 ***	(0.220)
adj R^2	0.140		0.307	
F	20.5 ***		86.9 ***	
AIC	-499.6		-54.0	

Heteroscedasticity-robust standard errors are presented in the parentheses.

*** 1%; **5%; * 10% level of significance

Again, having multiple counties merged into a prosecutorial district is associated with increased efficiency of production and, specifically, is associated with increasing returns to scale.

Next, the Propensity Score Matching results are presented. Table A3 presents the results from the calculation of the propensity scores. A logit regression is run using the treatment variable, *multiple*, as the dependent variable.

TABLE A3: PROPENSITY SCORING
(logit, dependent variable = *multiple*; $N = 2298$)

	logit coefficient	st. error
white	-5.095 ***	(0.517)
male	-12.251 ***	(3.979)
ur	0.098 *	(0.051)
lfpr	-0.026	(1.678)
income	-5.2x10^{-7}	(8.7x10^{-6})
education	-0.091 ***	(0.011)
poverty	-0.038 *	(0.205)
population	1.7x10^{-6} ***	(5.6x10^{-7})
rep	6.609 ***	(0.698)
voter part	0.126	(0.206)
violent	-2.6x10^{-4} ***	(8.7x10^{-5})
property	1.1x10^{-5}	(1.5x10^{-5})
constant	11.891 ***	(2.319)
McFadden R^2	0.208	
AIC	1566.3	
% correct	85.8%	

*** 1%; ** 5%; * 10% level of significance

The estimated coefficients are used to calculate the propensity score for each observation. The subsamples presented in Table 5 in the text matches, for each observation with *multiple* = 1, an observation in *multiple* = 0 with the closest propensity score (with replacement).

Alternatively, one can employ a caliper to restrict the control subsample to only those observations sufficiently close in propensity scores. A common caliper used in the literature is 0.001. Table A4 compares the means of the subsample of controls when this caliper is used. The first column also restricts the subsample of treated observations which have a match using this caliper. The third column provides the full sample of observations with *multiple* = 0.

TABLE A4: PSM RESULTS WITH CALIPER

	multiple = 1 (N = 205)	*control* (N = 191)	*multiple* = 0 (full sample)
TE	0.225	0.152	0.148
Closed	1866.8	1890.0	1146.0
Convict	1397.4	1435.9	869.1
Convict/Closed	0.749	0.760	0.758
Jury	44.534	40.96	29.26
Jury/Closed	0.024	0.022	0.026
# of investigators	2.661	4.054	2.485
% with an investigator	69.8%	46.6%	0.367
# of prosecutors	12.83	20.93	11.73
# of supporting staff	25.15	34.62	21.68
budget	2,194,297	4,969,548	2,615,133

An alternative econometric matching method is to account for the fact that two or more observations with *multiple* = 1 can be matched to the same control observation. For example, the results presented in Table 5 have 346 treated observations, but only 273 observations in the control subsample. An alternative is to use Weighted Least Squares where the weight assigned to the control subsample is equal to the number of times it is the best match to an observation in the treatment subsample. Table A5 presents the results.

TABLE A5: WEIGHTED LEAST SQUARES

	𝕀	𝕀𝕀𝕀
multiple	0.076 ***	0.076 ***
	(0.009)	(0.009)
jury/closed		0.039
		(0.047)
convict/closed		0.003
		(0.003)
constant	0.148 ***	0.145 ***
	(0.005)	(0.006)
adj R^2	0.112	0.109
AIC	-943.7	-938.6

Heteroscedasticity-robust standard errors are presented in the parentheses.

*** 1%; ** 5%; * 10% level of significance

The statistical significance of *multiple* is maintained in this estimation. Furthermore, adding controls for the important output considerations - the proportion of closed cases that lead to conviction and the proportion of closed cases that go to a jury trial - are shown to be statistically insignificant. This coincides with the results presented in Table 5.